IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application

Applicant(s): Boer et al.
Case: Boer 7-3-2-3
Serial No.: 10/562,618
Filing Date: May 15, 2006
Group: 2617
Examiner: Fred A. Casca

Title: Method and Apparatus for Communicating Symbols in a Multiple Input Multiple Output Communication System Using Interleaved Subcarriers Across a Plurality of Antennas

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REPLY BRIEF

Mail Stop Appeal Brief – Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Appellants hereby reply to the Examiner's Answer, mailed August 8, 2011 (referred to hereinafter as "the Examiner's Answer"), in an Appeal of the final rejection of claims 1-9 and 11-34 in the above-identified patent application.

REAL PARTY IN INTEREST

A statement identifying the real party in interest is contained in Appellants' Appeal Brief.

RELATED APPEALS AND INTERFERENCES

A statement identifying related appeals is contained in Appellants' Appeal Brief.

STATUS OF CLAIMS

A statement identifying the status of the claims is contained in Appellants' Appeal Brief.

STATUS OF AMENDMENTS

A statement identifying the status of the amendments is contained in Appellants' Appeal Brief.

SUMMARY OF CLAIMED SUBJECT MATTER

A Summary of the Invention is contained in Appellants' Appeal Brief.

STATEMENT OF GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A statement identifying the grounds of rejection to be reviewed on appeal is contained in Appellants' Appeal Brief.

CLAIMS APPEALED

A copy of the appealed claims is contained in an Appendix of Appellants' Appeal Brief.

ARGUMENT

Point 1

In the Examiner's Answer (pages 12-13), the Examiner asserts that the broadest reasonable interpretation of the claimed limitation "multiple antenna wireless communication system" is equivalent to any wireless communication system that has one antenna at the transmit side and one antenna at the receive side. The Examiner further asserts that Shattil's diagonal loading of symbols (e.g., w_1, w_1) across multiple antennas (e.g., one at the receive side and one at the transmit side) read on the claimed limitation based on a broad interpretation since neither the specification nor the claim language indicate how diagonal loading is performed.

As would be apparent to a person of ordinary skill in the art, "diagonal loading across multiple antennas" refers to a plurality of antennas *at the same transmitter*. (See, pages 5-6 of the originally filed disclosure.) For example, the present disclosure teaches:

FIG. 4 illustrates long training symbols for a MIMO-OFDM system in accordance with the present invention, where the subcarriers from the training symbol of FIG. 3 are diagonally loaded across three exemplary transmit antennas. FIG. 4 illustrates the first 16 subcarriers seen at the input of the Inverse Fast Fourier Transform (IFFT) for each of three antennas, t_l^1 through t_l^3, where t_l^n stands for the long training symbol transmitted on the n-th transmit antenna. In the example shown in FIG. 4, each subsequent subcarrier is transmitted on an adjacent antenna in a round robin fashion. Thus, only one-third of the subcarriers are transmitted on each antenna and the remaining subcarriers are nulled. (Page 5, line 27, to page 6, line 4; emphasis added.)

Thus, the Examiner's interpretation of the limitation "diagonal loading across multiple antennas" is inconsistent with the present disclosure and is *not* how a person of ordinary skill in the art would interpret the claim.

Finally, as was noted in the Appeal Brief, Shattil teaches a distribution of *sub-carrier weights* w_n. The distribution is over *frequency-time* channels. The rows and columns of FIG. 9A represent *frequency* and *time*, respectively; neither the rows nor the columns of FIG. 9A represent *different antennas*. Shattil does *not* disclose or suggest *diagonally loading subcarriers from one or more symbols* and does *not* disclose or suggest *diagonally loading across a plurality of antennas* in a multiple antenna wireless communication system. Moreover, Shattil does *not* teach diagonal loading of symbols across multiple antennas, *where one antenna is located at the receive side and one antenna is located at the transmit side*. Appellants emphasize that the Examiner has not explained how diagonal loading can be accomplished across antennas located at different units, especially where the units are different types of devices (e.g., receiver and transmitter)!

Point 2

In the Examiner's Answer (page 14), the Examiner asserts:

with regards to the nulling of subcarriers that are not diagonally loaded, the examiner asserts that figure 9B of Shattil shows that all the remaining subcarrier(s) that are not diagonally loaded are empty (nulled), thus it reads on the claimed language. Further, the examiner asserts that the claimed limitation, "diagonal loading," inherently implies that the non-diagonally loaded subcarriers are nulled. Further, figure 9B shows that a nulled subcarrier has at least one subcarrier located on each side of the nulled subcarrier.

As noted in the Appeal Brief, there is *no* teaching in Shattil that figure 9B of Shattil shows diagonal loading, or shows that all the remaining subcarrier(s) that are not

diagonally loaded are empty (nulled). Moreover, Shattil does *not* disclose or suggest **ensuring** *that any subcarrier that was nulled by said diagonal loading is surrounded by subcarriers that are not nulled.*

Point 3

In the Examiner's Answer (page 15), the Examiner asserts that Shattil, in FIG. 9B, discloses a large bandwidth (carrier) divided into (a) plurality of subcarriers where each subcarrier has its own time units, e.g., t_1, t_2, t_3 and t_4. Further, the examiner asserts that each subcarrier inherently can only be used either as receive subcarrier or transmit subcarrier because each time based portion of the frequency (also referred to as slot) can communicate only in one direction at the assigned given time period. Thus, each subcarrier is active either with transmit antenna or receive antenna at the given time. Thus, based on a broad interpretation of the claims, Shattil's disclosure reads on the claimed limitations.

Appellants note that the claims require that the "plurality of antennas" refers to *antennas at the transmitter.* For example, claim 26 and 29 require *transmitting* subcarriers from said one or more symbols *using a plurality of antennas* in said multiple antenna wireless communication system such that each of said subcarriers are active on only one of said plurality of antennas at a given time. Similarly, claims 31 and 33 require that the plurality of antennas refers to antennas at the transmitter. Appellants also note that any alleged teaching that "each subcarrier is active either with transmit antenna or receive antenna at the given time" does *not* teach that "each of said subcarriers are active on only one of said plurality of antennas at a given time" *where the antennas are at a transmitter.*

Point 4

In the Examiner's Answer (page 15), the Examiner asserts that the transmitting of long training symbols is conventional in IEEE 802.11 a/g and that it would have been obvious to transmit such long training symbols in the claimed diagonal format so that the transmitting of such training symbols do not interfere with each other.

As noted in the Appeal Brief, Shattil teaches:

[0163] FIG. 9A illustrates a distribution of sub-carrier weights w_n over a plurality of frequency-time channels. In particular, the sub-carrier weights w.sub.n are interleaved in time, such as to further reduce impulse noise or compensate for quickly varying channel and/or interference conditions. In FIG. 9B, weights are applied to time-frequency channels in a digital-chirp (i.e., frequency ramp) format. In FIG. 9C, sub-carrier weights may share the same time slots.

Shattil teaches a distribution of *sub-carrier weights* w_n. The distribution is over *frequency-time* channels. The rows and columns of FIG. 9A represent *frequency* and *time*, respectively; neither the rows nor the columns of FIG. 9A represent *different antennas*. Shattil does *not* disclose or suggest *wherein each subsequent subcarrier from a single-antenna long training symbol is positioned in a long training symbol for a **logically adjacent antenna***. Claims 2 and 22 requires *wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna.*

Thus, the Admitted Art and Shattil, alone or in combination, do not disclose or suggest wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna, as required by claims 2 and 22.

Point 5

In the Examiner's Answer (page 16), the Examiner asserts that the admitted art MIMO system inherently would include a MIMO channel matrix where the channel matrix can be diagonalized by using SVD decomposition, that an artesian would recognize that the SVD decomposition would change the channel matrix into a diagonal channel where only subcarrier on the diagonal are used (loaded) for communication, and that further each one of these diagonal subcarriers of the MIMO channel are used only by one transmit antenna on the transmitting side and one receive antenna on the receiving side. A similar argument is presented regarding claim 4.

As noted in the Appeal Brief, Shattil does *not* disclose or suggest *wherein each subsequent subcarrier from a single-antenna long training symbol is positioned in a long training symbol for a **logically adjacent antenna***.

Furthermore, the cited AAPA teaches *SVD decomposition*; the AAPA, however, does *not* teach that a change in a channel matrix *results in a diagonal channel where only subcarrier on the diagonal are used (loaded) for communication*, or that each one of these diagonal subcarriers of the MIMO channel are used only by one transmit antenna on the transmitting side and one receive antenna on the receiving side.

Point 6

In the Examiner's Answer (page 17), the Examiner asserts that an artesian would recognize a MIMO-OFDM channel is structured such that each MIMO subcarrier is turned into an OFDM carrier where *the OFDM carrier* is divided further into multiple smaller subcarriers and that an artesian would recognize that the Admitted Art's MIMO-OFDM system can be modified such that additional OFDM subcarriers are inserted in at least one of said plurality of symbols.

Appellants note that the Admitted Art teaches that "only 52 of the 64 subcarriers in the long training symbol are modulated." (Page 4, line 20, to page 5, line 10.) The Admitted Art does *not* disclose or suggest that the OFDM carrier is divided further into multiple smaller subcarriers, and does *not* disclose or suggest *inserting one or more additional subcarriers in at least one of a plurality of symbols.*

Point 7

In the Examiner's Answer (page 18), the Examiner asserts that, regarding claim 8, an artesian would be able to modify the cited references and come up with (the) claimed limitation since Shattil discloses that the subcarriers that are not in the diagonal are nulled, and that "it would increase orthogonally to put nulled subcarriers next to non-nulled ones."

As noted in the Appeal Brief, Joo teaches that "*a sub-carrier selection and frequency mask unit maps a second number of ARM code components to a second number of sub-carriers among a third number of OFDM sub-carriers distributed equally in a frequency band and maps null components to sub-carriers excluded from the second number of sub-carriers*" (paragraph [0025]); Joo does *not* disclose or suggest where one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by diagonal loading is surrounded by subcarriers that are not nulled.

Moreover, as noted above, Shattil does *not* disclose or suggest that subcarriers are diagonally loaded, or that subcarriers that are *not* diagonally loaded are nulled.

Finally, there is *no* disclosure or suggestion to put nulled subcarriers next to non-nulled ones, and *no* disclosure or suggestion in the cited prior art that putting nulled subcarriers next to non-nulled ones would increase orthogonality.

Point 8

In the Examiner's Answer (page 18), the Examiner asserts that, regarding claim 20, sending subsequent training symbols at different times would be inherent so the channel characteristics are known at different times, thus, (the) exchanging of long symbols as claimed is interpreted only as transmitting of long training symbols at different time periods.

As noted in the Appeal Brief, Joo teaches that "*a sub-carrier selection and frequency mask unit maps a second number of ARM code components to a second number of sub-carriers among a third number of OFDM sub-carriers distributed equally in a frequency band and maps null components to sub-carriers excluded from the second number of sub-carriers*" (paragraph [0025]); Joo does *not* disclose or suggest *wherein a reduced number of subcarriers are* <u>*inserted*</u> *in at least one of a plurality of long training symbols* and *wherein a first long training symbol and a second long training symbol are* <u>**interchanged**</u> <u>*to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier.*</u>

Furthermore, contrary to the Examiner's assertion, <u>**interchanging** *a first long training symbol and a second long training symbol to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier*</u> is *not* equivalent to *the transmission of long training symbols* <u>*at different time periods*</u>, as would be apparent to a person of ordinary skill in the art.

Finally, it is noted that sending subsequent training symbols at different times would *not* be inherent in the disclosed system(s), and it is noted that the Examiner has presented *no* evidence to support this assertion.

Point 9

In the Examiner's Answer (pages 18-19), the Examiner asserts:

the Admitted Art's diagonal loading of symbols can also be the diagonal loading of packets including the headers of the packets. Further, the claimed "logically adjacent antennas" are interpreted as two MIMO transmit antennas next to each other as disclosed in Admitted Art Figure 1, e.g., TX_1 and TX_2 are interpreted as adjacent antennas. Further, the V-Blast document by Wolniansky teaches data sequences (e.g., a_1, a_2, a_3 and a_4) of a packet (e.g., a) is loaded (e.g., to be transmitted) diagonally (see Wolniansky, the column under Introduction, particularly, lines 9-13, "D-Blast utilizes multi-element antenna arrays at both transmitter and receiver and an elegant diagonally-layered coding structure in which code blocks are dispersed across diagonals in space-time").

It is noted that, in the previous Office Action, the Examiner acknowledged that the Admitted Art does *not* specifically disclose that the symbols are loaded diagonally, and

Appellants note that the Examiner has presented *no* evidence to counter this assertion; Appellants find *no* disclosure or suggestion in the Admitted Art that the symbols are loaded diagonally. Wolniansky, for example, teaches a diagonally-layered coding structure, but does not disclose or suggest diagonal loading, as defined in the context of the present invention.

5   Also, as noted above, Shattil teaches a distribution of *sub-carrier weights* w_n. The distribution is over *frequency-time* channels. The rows and columns of FIG. 9A represent *frequency* and *time*, respectively; neither the rows nor the columns of FIG. 9A represent *different antennas*. The cited art does *not* disclose or suggest *diagonally loading* a remainder of a header of a packet across *logically adjacent antennas*; and does *not* disclose or suggest *diagonally*

10 *loading* data sequences of a packet across *logically adjacent antennas*.

Appeal Brief Arguments

Independent claims 1, 17, 21, 26, 29, and 31-34

Independent claims 1, 21, 26, 29, and 31-34 were rejected under 35 U.S.C.

15 §103(a) as being unpatentable over Applicant's Background Disclosure in the Specification, particularly Figures 1-3 and page 4, line 18 through page 5, line 19 (Admitted Art) in view of Shattil, and independent claims 8, 17, 18, 20, 26, 29, and 31-34 were rejected under 35 U.S.C. §103(a) as being unpatentable over Admitted Art in view of Shattil and further in view of Joo. Regarding claim 1, the Examiner acknowledges that the Admitted Art does not specifically

20 disclose that the symbols are loaded diagonally, but asserts that Shattil discloses that symbols are loaded into subcarriers diagonally (FIG. 9A and paragraph 0163).

Applicants note that, in the text cited by the Examiner, Shattil teaches:

[0163] FIG. 9A illustrates a distribution of sub-carrier weights w_n over a plurality of frequency-time channels. In particular, the sub-carrier weights w_n are

25   interleaved in time, such as to further reduce impulse noise or compensate for quickly varying channel and/or interference conditions. In FIG. 9B, weights are applied to time-frequency channels in a digital-chirp (i.e., frequency ramp) format. In FIG. 9C, sub-carrier weights may share the same time slots.

Shattil teaches a distribution of *sub-carrier weights* w_n. The distribution is over

30 *frequency-time* channels. The rows and columns of FIG. 9A represent *frequency* and *time*, respectively; neither the rows nor the columns of FIG. 9A represent *different antennas*. Shattil does *not* disclose or suggest *diagonally loading subcarriers from one or more symbols* and does *not* disclose or suggest *diagonally loading across a plurality of antennas* in a multiple antenna

wireless communication system. Independent claims 1 and 21 require *diagonally loading subcarriers from said one or more symbols across a plurality of antennas* in said multiple antenna wireless communication system. Independent claim 17 requires *diagonally loading subcarriers from a single-antenna long training symbol across long training symbols associated with logically adjacent antennas* in said multiple antenna wireless communication system; nulling subcarriers in said plurality of long training symbols that are not diagonally loaded; and inserting at least one additional subcarrier to ensure that a nulled subcarrier has at least one subcarrier located on each side of said nulled subcarrier. Independent claims 26 and 29 require transmitting subcarriers from said one or more symbols using a plurality of antennas in said multiple antenna wireless communication system *such that each of said subcarriers are active on only one of said plurality of antennas at a given time.* Independent claims 31 and 33 require aggregating subcarriers from said one or more symbols that were transmitted such that *each of said subcarriers are active on only one of said plurality of antennas at a given time.* Claims 32 and 34 require *wherein said subcarriers are diagonally loaded across said plurality of antennas.*

Thus, the Admitted Art and Shattil, alone or in combination, do not disclose or suggest diagonally loading subcarriers from said one or more symbols across a plurality of antennas in said multiple antenna wireless communication system, as required by independent claims 1 and 21, do not disclose or suggest diagonally loading subcarriers from a single-antenna long training symbol across long training symbols associated with logically adjacent antennas in said multiple antenna wireless communication system; nulling subcarriers in said plurality of long training symbols that are not diagonally loaded; and inserting at least one additional subcarrier to ensure that a nulled subcarrier has at least one subcarrier located on each side of said nulled subcarrier, as required by independent claim 17, do not disclose or suggest transmitting subcarriers from said one or more symbols using a plurality of antennas in said multiple antenna wireless communication system such that each of said subcarriers are active on only one of said plurality of antennas at a given time, as required by independent claims 26 and 29, do not disclose or suggest aggregating subcarriers from said one or more symbols that were transmitted such that each of said subcarriers are active on only one of said plurality of antennas at a given time, as required by independent claims 31 and 33, and do not disclose or suggest wherein said subcarriers are diagonally loaded across said plurality of antennas, as required by claims 32 and 34.

<u>Claims 2 and 22</u>

Claims 2 and 22 were rejected under 35 U.S.C. §103(a) as being unpatentable over the Admitted Art in view of Shattil. Regarding claim 2, the Examiner asserts that the combination of the Admitted Art and Shattil discloses wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna (the diagonal loading of symbols in Shattil implies that each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna).

As noted above, Shattil teaches:

> [0163] FIG. 9A illustrates a distribution of sub-carrier weights w_n over a plurality of frequency-time channels. In particular, the sub-carrier weights w.sub.n are interleaved in time, such as to further reduce impulse noise or compensate for quickly varying channel and/or interference conditions. In FIG. 9B, weights are applied to time-frequency channels in a digital-chirp (i.e., frequency ramp) format. In FIG. 9C, sub-carrier weights may share the same time slots.

Shattil teaches a distribution of *sub-carrier <u>weights</u>* w_n. The distribution is over *<u>frequency-time</u>* channels. The rows and columns of FIG. 9A represent *frequency* and *time*, respectively; neither the rows nor the columns of FIG. 9A represent *different antennas*. Shattil does *not* disclose or suggest *wherein <u>each subsequent subcarrier</u> from a single-antenna long training symbol is <u>positioned in a long training symbol</u> for a **<u>logically adjacent antenna</u>**. Claims 2 and 22 requires *wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna.*

Thus, the Admitted Art and Shattil, alone or in combination, do not disclose or suggest wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna, as required by claims 2 and 22.

Claim 4

Claim 4 was rejected under 35 U.S.C. §103(a) as being unpatentable over the Admitted Art in view of Shattil. Regarding claim 4, the Examiner asserts that the combination of the Admitted Art and Shattil discloses wherein said one or more symbols are short training symbols based on a single-antenna short training symbol and wherein each subsequent subcarrier from said single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna (Admitted Art: FIG. 3 and page 5, lines 5-10, "short training symbols").

As the Examiner notes, the Admitted Art discloses short training symbols (page 5, lines 5-10); the Admitted Art does *not* disclose or suggest *wherein each subsequent subcarrier from a single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna*. Moreover, as noted above, Shattil teaches a distribution of *subcarrier weights* w_n. The distribution is over *frequency-time channels*. The rows and columns of FIG. 9A represent *frequency* and *time*, respectively; neither the rows nor the columns of FIG. 9A represent *different antennas*. Shattil does *not* disclose or suggest *wherein each subsequent subcarrier from a single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna*. Claim 4 requires *wherein said one or more symbols are short training symbols based on a single-antenna short training symbol and wherein each subsequent subcarrier from said single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna*.

Thus, the Admitted Art and Shattil, alone or in combination, do not disclose or suggest wherein said one or more symbols are short training symbols based on a single-antenna short training symbol and wherein each subsequent subcarrier from said single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna, as required by claim 4.

Claims 7

Claim 7 was rejected under 35 U.S.C. §103(a) as being unpatentable over the Admitted Art in view of Shattil. Regarding claim 7, the Examiner asserts that the combination of the Admitted Art and Shattil discloses inserting one or more additional subcarriers in at least one of said plurality of symbols (Admitted Art: page 4, line 20, to page 5, line 10: inserting additional subcarriers is inherent in OFDM).

In the text cited by the Examiner, the Admitted Art teaches that "only 52 of the 64 subcarriers in the long training symbol are modulated." (Page 4, line 20, to page 5, line 10.) The Admitted Art does *not* disclose or suggest *inserting one or more additional subcarriers in at least one of a plurality of symbols.* Claim 7 requires inserting one or more additional subcarriers in at least one of said plurality of symbols.

Thus, the Admitted Art and Shattil, alone or in combination, do not disclose or suggest inserting one or more additional subcarriers in at least one of said plurality of symbols, as required by claim 7.

Claim 8

Claim 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over the Admitted Art in view of Shattil, and further in view of Joo. In particular, the Examiner asserts that Joo discloses nulling subcarriers that are not diagonally loaded and inserting non-nulled subcarriers adjacent to nulled subcarriers (abstract and paragraph 25).

In the text cited by the Examiner, Joo teaches that *"a sub-carrier selection and frequency mask unit maps a second number of ARM code components to a second number of sub-carriers among a third number of OFDM sub-carriers distributed equally in a frequency band and maps null components to sub-carriers excluded from the second number of sub-carriers"* (paragraph [0025]); Joo does *not* disclose or suggest where one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by diagonal loading is surrounded by subcarriers that are not nulled. Claim 8 requires where said one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by said diagonal loading is surrounded by subcarriers that are not nulled.

Thus, the Admitted Art, Shattil and Joo, alone or in combination, do not disclose or suggest where said one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by said diagonal loading is surrounded by subcarriers that are not nulled, as required by claim 8.

Claim 20

Claim 20 was rejected under 35 U.S.C. §103(a) as being unpatentable over the Admitted Art in view of Shattil and further in view of Joo. Regarding claim 20, the Examiner asserts that the combination of the Admitted Art, Shattil and Joo discloses wherein a reduced number of subcarriers are inserted in said at least one of said plurality of long training symbols

and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier (citing paragraph [0025] of Joo).

In the text cited by the Examiner, Joo teaches that "*a sub-carrier selection and frequency mask unit maps a second number of ARM code components to a second number of sub-carriers among a third number of OFDM sub-carriers distributed equally in a frequency band and maps null components to sub-carriers excluded from the second number of sub-carriers*" (paragraph [0025]); Joo does *not* disclose or suggest *wherein a reduced number of subcarriers are* <u>*inserted*</u> *in at least one of a plurality of long training symbols* and *wherein a first long training symbol and a second long training symbol are* **<u>interchanged</u>** <u>*to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier*</u>. Claim 20 requires *wherein a reduced number of subcarriers are inserted in said at least one of said plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier.*

Thus, the Admitted Art, Shattil and Joo, alone or in combination, do not disclose or suggest wherein a reduced number of subcarriers are inserted in said at least one of said plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier, as required by claim 20.

<u>Claims 14 and 25</u>

Claims 14 and 25 were rejected under 35 U.S.C. §103(a) as being unpatentable over the Admitted Art in view of Shattil. Regarding claim 14, the Examiner asserts that the combination of the Admitted Art and Shattil discloses diagonally loading a remainder of a header of a packet across said logically adjacent antennas; and diagonally loading data sequences of said packet across said logically adjacent antennas (FIGS. 1-3; page 4, line 20, to page 5, line 18).

As noted above, Shattil teaches a distribution of *sub-carrier* <u>*weights*</u> w_n. The distribution is over <u>*frequency-time*</u> *channels*. The rows and columns of FIG. 9A represent *frequency* and *time*, respectively; neither the rows nor the columns of FIG. 9A represent *different antennas.* Shattil does *not* disclose or suggest <u>*diagonally loading*</u> *a remainder of a header of a packet across* <u>*logically adjacent antennas*</u>; and does *not* disclose or suggest <u>*diagonally loading*</u>

data sequences of a packet across logically adjacent antennas. Claims 14 and 25 require diagonally loading a remainder of a header of a packet across said logically adjacent antennas; and diagonally loading data sequences of said packet across said logically adjacent antennas.

Thus, the Admitted Art and Shattil, alone or in combination, do not disclose or suggest diagonally loading a remainder of a header of a packet across said logically adjacent antennas; and diagonally loading data sequences of said packet across said logically adjacent antennas, as required by claims 14 and 25.

Conclusion

The rejections of the cited claims under section 103 in view of Shattil, Joo, the Admitted Art, and the well know prior art, alone or in any combination, are therefore believed to be improper and should be withdrawn. The remaining rejected dependent claims are believed allowable for at least the reasons identified above with respect to the independent claims.

The attention of the Examiner and the Appeal Board to this matter is appreciated.

Respectfully,

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CLAIMS APPENDIX

1.   A method for transmitting one or more symbols in a multiple antenna wireless communication system, said method comprising the step of:

5   diagonally loading subcarriers from said one or more symbols across a plurality of antennas in said multiple antenna wireless communication system.

2.   The method of claim 1, wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier

10   from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna.

3.   The method of claim 2, wherein said single-antenna long training symbol is an 802.11 a/g long training symbol.

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4.   The method of claim 1, wherein said one or more symbols are short training symbols based on a single-antenna short training symbol and wherein each subsequent subcarrier from said single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna.

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5.   The method of claim 4, wherein said single-antenna short training symbol is an 802.11 a/g short training symbol.

6.   The method of claim 1, wherein said multiple antenna wireless communication

25   system is a MIMO-OFDM system.

7.   The method of claim 1, further comprising the step of inserting one or more additional subcarriers in at least one of said plurality of symbols.

30   8.   The method of claim 7, where said one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by said diagonal loading is surrounded by

subcarriers that are not nulled.

9.   The method of claim 7, where said one or more additional subcarriers allow nulled subcarriers to be estimated using an interpolation-based channel estimation technique.

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10.   The method of claim 2, wherein a reduced number of subcarriers are inserted in said at least one of said plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier.

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11.   The method of claim 1, wherein said one or more symbols are a SIGNAL-field symbol.

12.   The method of claim 11, wherein said SIGNAL-field symbol includes a system 15   type indicator.

13.   The method of claim 2, wherein a number of said long training symbols is a function of the number of transmitters.

20   14.   The method of claim 1, further comprising the steps of:
        diagonally loading a remainder of a header of a packet across said logically adjacent antennas; and
        diagonally loading data sequences of said packet across said logically adjacent antennas.

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15.   The method of claim 1, wherein said plurality of antennas are logically adjacent.

16.   The method of claim 1, whereby a lower order receiver can interpret said transmitted diagonally loaded symbols as a normal OFDM frame.

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17.   A method for generating a plurality of long training symbols in a multiple antenna wireless communication system, said method comprising the step of:

diagonally loading subcarriers from a single-antenna long training symbol across long training symbols associated with logically adjacent antennas in said multiple antenna wireless communication system;

nulling subcarriers in said plurality of long training symbols that are not diagonally loaded; and

inserting at least one additional subcarrier to ensure that a nulled subcarrier has at least one subcarrier located on each side of said nulled subcarrier.

18.   The method of claim 17, wherein said single-antenna long training symbol is an 802.11 a/g long training symbol.

19.   The method of claim 17, where said at least one additional subcarrier allows nulled subcarriers to be estimated using an interpolation-based channel estimation technique.

20.   The method of claim 17, wherein a reduced number of subcarriers are inserted in at least one of said plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier.

21.   A transmitter in a multiple antenna wireless communication system, comprising:

a plurality of transmit antennas, wherein subcarriers of one or more symbols are diagonally loaded across logically adjacent antennas.

22.   The transmitter of claim 21, wherein said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna.

23.   The transmitter of claim 21, wherein said multiple antenna wireless communication system is a MIMO-OFDM system.

24.   The transmitter of claim 21, wherein said one or more symbols are a SIGNAL-field symbol.

25.   The transmitter of claim 21, wherein:

a remainder of a header of a packet are diagonally loaded across said logically adjacent antennas; and

data sequences of said packet are diagonally loaded across said logically adjacent antennas.

26.   A method for transmitting one or more symbols in a multiple antenna wireless communication system, said method comprising the step of:

transmitting subcarriers from said one or more symbols using a plurality of antennas in said multiple antenna wireless communication system such that each of said subcarriers are active on only one of said plurality of antennas at a given time.

27.   The method of claim 26, wherein said transmitting step further comprises the step of diagonally loading said subcarriers across said plurality of antennas.

28.   The method of claim 26, wherein said plurality of antennas are logically adjacent.

29.   A transmitter in a multiple antenna wireless communication system, comprising:

a plurality of transmit antennas for transmitting subcarriers from one or more symbols such that each of said subcarriers are active on only one of said plurality of antennas at a given time.

30.   The transmitter of claim 29, wherein said subcarriers are diagonally loaded across said plurality of antennas.

31.   A method for receiving one or more symbols on at least one receive antenna transmitted by a transmitter having a plurality of transmit antennas in a multiple antenna wireless communication system, said method comprising the step of:

        aggregating subcarriers from said one or more symbols that were transmitted such that each of said subcarriers are active on only one of said plurality of antennas at a given time.

32.   The method of claim 31, wherein said subcarriers are diagonally loaded across said plurality of antennas.

33.   A receiver in a multiple antenna wireless communication system having at least one transmitter having a plurality of transmit antennas, comprising:

        at least one receive antenna; and

        an aggregator for aggregating subcarriers from one or more symbols that were transmitted such that each of said subcarriers are active on only one of said plurality of antennas at a given time.

34.   The receiver of claim 33, wherein said subcarriers are diagonally loaded across said plurality of antennas.

EVIDENCE APPENDIX

There is no evidence submitted pursuant to § 1.130, 1.131, or 1.132 or entered by the Examiner and relied upon by appellant.

RELATED PROCEEDINGS APPENDIX

There are no known decisions rendered by a court or the Board in any proceeding identified pursuant to paragraph (c)(1)(ii) of 37 CFR 41.37.